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(54) Quality assurance for brachytherapy using a dose measuring system

(57) The application relates to a process for brachytherapy by using a dose measuring system (4), wherein, in at least one point (9,10,11) of an area (12) subjected to radiation treatment, the individual radiation dose contribution (Dnm) from at least one dwell position (X_1-X_n) of at least one radiation source is measured in real time, the thus obtained measured dose value is compared with the corresponding value calculated by a treatment planning system (1), and the further course of the treatment is adapted on the basis of the degree of agreement between the measured value and the calculated value. The invention relates to a control program, a treatment control system (3), a treatment planning system (1) and a dose measured system (4).

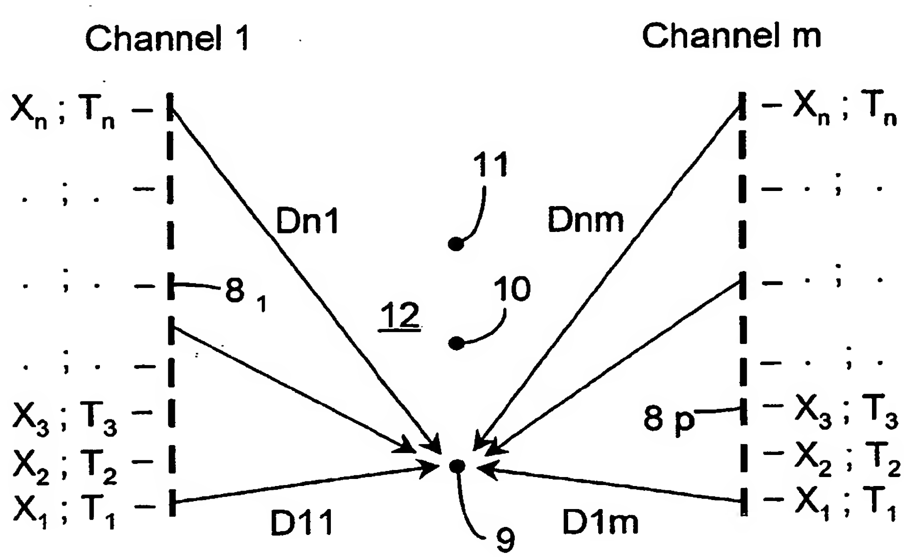

Fig. 2

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Description

[0001] The present invention relates to a process for achieving quality assurance in the field of brachytherapy, a control program, a treatment planning system and control system, and a dose measuring system.

[0002] In the present context of the field of brachytherapy, quality assurance comprises quality assurance on the treatment unit, quality assurance on the treatment planning system, and quality assurance on the treatment procedure. Brachytherapy treatment errors which are difficult to detect can occur in the following areas: patient and treatment planning identification, applicator identification, applicator displacement, correct positioning of the radioactive sources, and treatment times. Treatment errors also comprise reconstruction errors.

[0003] Processes for achieving quality assurance in the field of brachytherapy by using a dose measuring system are known. Existing brachytherapy devices receive coordinates of dwell positions and dwell times of radioactive radiation sources from a treatment planning system. Although the individual contributions from the dwell positions reaching a particular point in the treatment area are calculated in the presently marketed treatment planning systems, these values are merely used to calculate the total dose contributions in the different points on a theoretical basis.

[0004] The existing treatment planning systems transfer the following parameters to the treatment control stations comprising the treatment control program: patient data, and, concerning the radioactive radiation sources, channel numbers (C_1-C_m), dwell positions (X_1-X_n) and dwell times (T_1-T_n). A remote afterloading control program will execute said prescribed parameters, but no intelligence is implemented to control any applied dose at a particular point within the treatment area on a real time basis. Only the dwell times are controlled.

[0005] The existing processes offer no possibility to detect and stop an incorrect administration of radiation, particularly in the initial stage of the treatment. Controlling the most important treatment parameter, i.e. the actual dose which is applied to a point within the treatment area on a real time basis, would provide a highly desired improvement over existing processes for achieving quality assurance in the field of brachytherapy. Presently marketed treatment control programs connected with dose measuring systems enable the practitioner only to measure doses with rectal probes, and to switch of the treatment if the dose value on one of the rectal probes reaches a predetermined limit value. Thus, while existing systems can be used to protect critical organs like the rectum, they cannot be used to achieve real time quality assurance of the treatment, with a view to detecting the above-mentioned treatment errors.

[0006] The process for achieving quality assurance in the field of brachytherapy by using a dose measuring system according to the present invention is characterised in that, in at least one point of an area subjected to radiation treatment, (i) the individual radiation dose contribution from at least one dwell position of at least one radiation source is measured in real time, (ii) the thus obtained measured dose value is compared with the corresponding value calculated by a treatment planning system, and (iii) the further course of the treatment is adapted on the basis of the degree of agreement between said measured value and said calculated value.

[0007] According to the present invention, the calculated individual dose contributions from the dwell positions at particular point with the treatment area, are individually stored and transferred to a control system of the remote brachytherapy afterloading stepping device, and are compared step by step with the individual dose values measured in real time with the dosimetry system.

[0008] According to the invention, the control program of the stepping device not only controls and supervises the afterloading stepping device, but also measures the times of the dosimetry system. Thus, the present process will allow step by step control during the treatment procedure, by automated comparison of the actual measured dose contributions from each source position at a particular point with the doses calculated by the planning system. The treatment planning system used according to the present process will store in a table the individual dose contributions from each source position with respect to a predetermined point within the treatment area, and will transfer these individual dose contributions to the treatment control program, together with the other treatment parameters.

[0009] The present process is preferably applied to one of (a) high dose rate afterloading brachytherapy, and (b) pulsed low dose rate afterloading brachytherapy. In the context of the present invention, high dose rate brachytherapy means applying a dose of about 10 Curie and more, and low dose rate brachytherapy means applying doses of less than 1 Curie.

[0010] Advantageously, the point of measuring said dose contribution is situated in the actual tissue which is being treated. According to a preferred aspect of the present invention, said tissue is the prostate gland.

[0011] Preferably, the at least one individual dose contribution is measured using an instant dose readout dosimeter system, with a probe inserted in the predetermined point in the area subjected to treatment. Advantageously, the process according to the present invention is characterised in that in the least one point, several individual dose contributions (D_1-D_n) from several dwell positions (X_1-X_n), each with corresponding dwell times (T_1-T_n), in several channels (C_1-C_m), are measured in real time. Furthermore, the calculated value(s) is (are) individually stored and transferred to a treatment control program, and is (are) compared step by step with the measured dose value(s).

[0012] The present invention also relates to a control program for a remote brachytherapy afterloading device, which compares the calculated value(s) with the measured value(s) obtained by using the present proc-

ess. Furthermore, the invention relates to a treatment control system comprising said control program connected with a real time dose measuring system. The invention also provides a treatment planning system for carrying out the above described process.

[0013] Finally, the present invention provides a dose measuring system, wherein individual measuring times for (an individual predetermined point(s) in an area treated by brachytherapy are controlled by the present control program, and are equal with dwell position times (T_1 - T_n) of at least one radiation source.

[0014] The above-mentioned features and advantages of the present invention are now illustrated in the following description with reference to the enclosed drawings.

[0015] Figure 1 shows a block diagram of a treatment system for brachytherapy in accordance with the present invention.

[0016] Figure 2 shows, in a schematic and illustrative manner, radiation dose measuring in accordance with the present invention.

[0017] As shown in Figure 1, a treatment system for performing brachytherapy in accordance with the present invention essentially comprises a treatment planning system 1, an afterloading device 2, a treatment control system 3, and a dose measuring system 4.

[0018] The treatment planning system 1 generally comprises a computer, such as a personal computer, which is used for treatment planning purposes by a physician or other person applying the brachytherapy treatment. That is, amongst others, for calculating planning parameters such as dwell positions and dwell times of radioactive sources in a plurality of channels of the afterloading device 2.

[0019] Afterloading devices for brachytherapy are as such known to those skilled in the art. No further elucidation seems required here.

[0020] The treatment planning system 1 connects to a treatment control system 3. The control system 3 operatively connects to the afterloading device 2 for controlling the position of one or a plurality of radiation sources in the channels of the afterloading device 2.

[0021] The dose measuring system 4 comprises a measuring probe 5 for measuring the radiation dose at a particular treatment point in an area to be treated.

[0022] In accordance with the present invention, the individual radiation dose contribution of at least one radiation source at at least one dwell position is measured by the radiation dose measurement system 4 in real time. The obtained measured dose value is compared with the corresponding value obtained from the treatment planning system 1. To this end, in the embodiment shown, the treatment control system 3 is provided with processor means 6 for comparing the actually measured dose value with the corresponding planned dose value stored in storage means 7.

[0023] Figure 2 shows, in a schematic and illustrative manner, a plurality of channels C_1-C_m, in each of which at least one radiation source 8_1-8_p can be moved.

[0024] During treatment, the radiation source in a particular channel is positioned at several pre-calculated dwell positions X_1-X_n. At the position of the probe 5, the dose contributions Dnm of the individual radiation sources in the several channels C_1-C_m at their various dwell positions X_1-X_n are measured in real time. Dnm denotes the dose contribution of a particular radiation source 8_1-8_p at a particular dwell position X_1-X_n in a particular channel C_1-C_m.

[0025] In accordance with the present invention, the measured dose values are compared in real time with the calculated values from the treatment planning system 1 by the processor means 6 in the control system 3, in accordance with a dose control program forming part of the present invention.

[0026] If the measured value differs from the calculated value, the control system 3 adapts either one or both the dwell positions X_1-X_n and the dwell times T_1-T_n of one or a plurality of the radiation sources in the channels C_1-C_m, in order to meet the planned treatment values as closely as possible.

[0027] It will be appreciated that the measuring probe 5 can be positioned at any position 9, 10, 11 in the area 12 to be treated in order to achieve an optimal quality assurance.

Claims

1. Process for brachytherapy by using a dose measuring system, **characterised in that**, in at least one point of an area subjected to radiation treatment, (i) the individual radiation dose contribution from at least one dwell position of at least one radiation source is measured in real time, (ii) the thus obtained measured dose value is compared with the corresponding value calculated by a treatment planning system, and (iii) the further course of the treatment is adapted on the basis of the degree of agreement between said measured value and said calculated value.

2. Process according to claim 1, **characterised in that** it is applied to one of (a) high dose rate afterloading brachytherapy, and (b) pulsed low dose rate afterloading brachytherapy.

3. Process to claim 1 of claim 2, **characterised in that** the point of measuring said dose contribution is situated in the actual tissue being treated.

4. Process according to claim 3, **characterised in that** said tissue is the prostate gland.

5. Process to any one of claims 1-4, **characterised in that** the at least one individual dose contribution is measured using an instant dose readout dosimeter

system, with a probe inserted in the predetermined point in the area subjected to treatment.

6. Process according to any one of claims 1-5, **characterised in that**, in the at least one point, several individual dose contributions (D_1-D_n) from several dwell positions (X_1-X_n), each with corresponding dwell times (T_1-T_n), in several channels (C_1-C_m), are measured in real time.

7. Process according to any one of claims 1-6, **characterised in that** calculated value(s) is (are) individually stored and transferred to a treatment control program, and is (are) compared step by step with the measured dose value(s).

8. Control program for a remote brachytherapy afterloading device, **characterised in that** it compares the calculated value(s) with the measured value(s) obtained using the process according to any one of claims 1-7.

9. Treatment control system for a remote brachytherapy afterloading device, **characterised in that** it comprises a control program according to claim 8, connected with a real time dose measuring system.

10. Treatment planning system for a remote brachytherapy afterloading device, for carrying out the process according to claim 7.

11. Dose measuring system, **characterised in that** individual measuring times for (an) individual predetermined point(s) in an area treated by brachytherapy are controlled by a control program according to claim 8, and are equal with dwell position times (T_1 - T_n) of at least one radiation source.

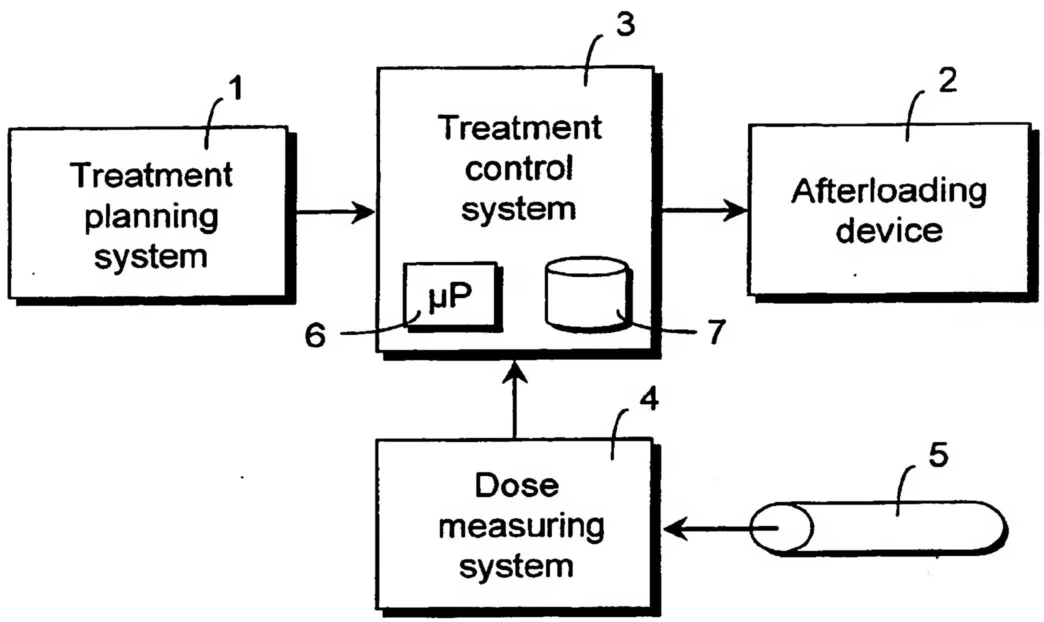
Treatment planning system
1
Treatment control system
3
μP
6
7
Afterloading device
2
Dose measuring system
4
5

Fig. 1

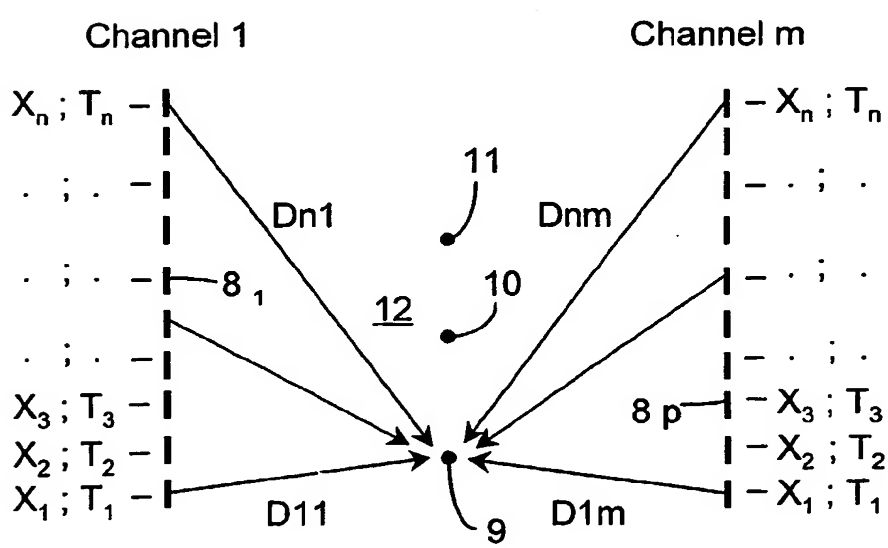
Channel 1
Channel m
X$_n$; T$_n$
. ; .
8 1
X$_3$; T$_3$
X$_2$; T$_2$
X$_1$; T$_1$
Dn1
Dnm
11
10
12
8 p
D11
9
D1m

Fig. 2

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PARTIAL EUROPEAN SEARCH REPORT

which under Rule 45 of the European Patent Convention shall be considered, for the purposes of subsequent proceedings, as the European search report

Application Number
EP 01 20 4628

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
X	ALECU ET AL.: "A method to avoid misadministrations in high dose rate brachytherapy" MEDICAL PHYSICS, vol. 24, no. 2, February 1997 (1997-02), pages 259-261, XP002193864 * the whole document *	9-11	A61N5/10
X	US 6 320 935 B1 (BUKSHPAN SHMUEL ET AL) 20 November 2001 (2001-11-20) * column 4, line 45 - column 5, line 28 *	9-11	
X	DE 198 54 287 A (LEONHARDT JUERGEN) 8 June 2000 (2000-06-08) * the whole document *	9-11	
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TECHNICAL FIELDS SEARCHED (Int.Cl.7)

A61N

INCOMPLETE SEARCH

The Search Division considers that the present application, or one or more of its claims, does/do not comply with the EPC to such an extent that a meaningful search into the state of the art cannot be carried out, or can only be carried out partially, for these claims.

Claims searched completely :

Claims searched incompletely :

Claims not searched :

Reason for the limitation of the search:

see sheet C

Place of search	Date of completion of the search	Examiner
THE HAGUE	22 March 2002	Petter, E

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C07)

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INCOMPLETE SEARCH SHEET C

Application Number
EP 01 20 4628

Claim(s) searched completely:
9-11

Claim(s) not searched:
1-8

Reason for the limitation of the search (non-patentable invention(s)):

Article 52 (4) EPC - Method for treatment of the human or animal body by therapy. Claim 1 is a process which includes the step of adapting the treatment. The program of claim 8 includes only method steps, including the steps of claim 1, and is therefore also a method of treatment.

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PARTIAL EUROPEAN SEARCH REPORT

Application Number
EP 01 20 4628

DOCUMENTS CONSIDERED TO BE RELEVANT			CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	
X	GLADSTONE D J ET AL: "AUTOMATED DATA COLLECTION AND ANALYSIS SYSTEM FOR MOSFET RADIATION DETECTORS" MEDICAL PHYSICS, AMERICAN INSTITUTE OF PHYSICS. NEW YORK, US, vol. 18, no. 3, 1 May 1991 (1991-05-01), pages 542-548, XP000236953 ISSN: 0094-2405 * page 547, column 1, paragraph 2 - paragraph 3 *	9-11	
A	WO 99 60921 A (BURDETTE MEDICAL SYSTEMS) 2 December 1999 (1999-12-02) * page 7, paragraph 2 - page 9, paragraph 2 * * page 19, paragraph 3 - page 20, paragraph 1 *	9-11	TECHNICAL FIELDS SEARCHED (Int.Cl.7)

EPO FORM 1503 03.82 (P04C10)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 01 20 4628

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The members are as contained in the European Patent Office EDP file on
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22-03-2002

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